Portable, Low-Power, Mechanically-Cooled Ge Spectrometer

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Field use of Germanium gamma-ray spectrometers is often limited by the availability of liquid nitrogen required for cooling, or by the weight and power of most mechanical coolers. We have constructed a small, portable Germanium spectrometer which takes advantage of a commercial mechanical microcooler[1]. A 5 cm × 5 cm coaxial Germanium detector is cooled to the operating temperature required to achieve the excellent resolution and line shape characteristic of Germanium spectrometers. The Germanium detector is hermetically encapsulated[2] within a thin aluminum can with 2 + atmospheres of nitrogen blanket gas. Two other enabling technologies include the use of an external metal vacuum getter, and a miniature ion-pump both of which are used to attain and maintain the utility vacuum. The result is a Germanium gamma ray spectrometer that has near laboratory resolution, is light in weight and therefore portable, and has low power requirements. Companion low-power electronics were also developed for pulse shaping, histogram collection, and control. Features of the spectrometer are:

- Ge detector
  - 5 cm diameter x 5 cm long
  - Resolution ~ 3.5 keV at E_γ = 662 keV
  - ~25% efficient relative to 3 x 3" NaI
  - Hermetically encapsulated, nitrogen blanket
- Mechanical cooler, Stirling Cycle
  - Hymatic Engineering
  - Lifetime > 30,000 hours
- Continuous unattended operation
  - ≥ 6 months
- BGO suppression shield (Removable)
  - Improved sensitivity and directionality
  - Reduced background
- Low weight – total = ~ 20 lbs
  - Ge detector + cooler, ~ 10 lbs
  - Detachable suppression shield, 10 lbs
- Low system power
  - 15 Watts, or less
- Integrated electronics
  - 12 bit Nuclear quality ADC
  - 16 Channels data storage (i.e., 16 histograms)
- Operating temperature:
  - - 40 ° C – + 40° C

The concept and present hardware are illustrated in Figure 1. Clearly, reasonably sized Germanium spectrometers are now available for field use. Future developments include installation of a cooled FET preamplifier, in which case we expect laboratory resolution. We anticipate that larger detectors, perhaps 50—80% efficient, can also be cooled with this technique.

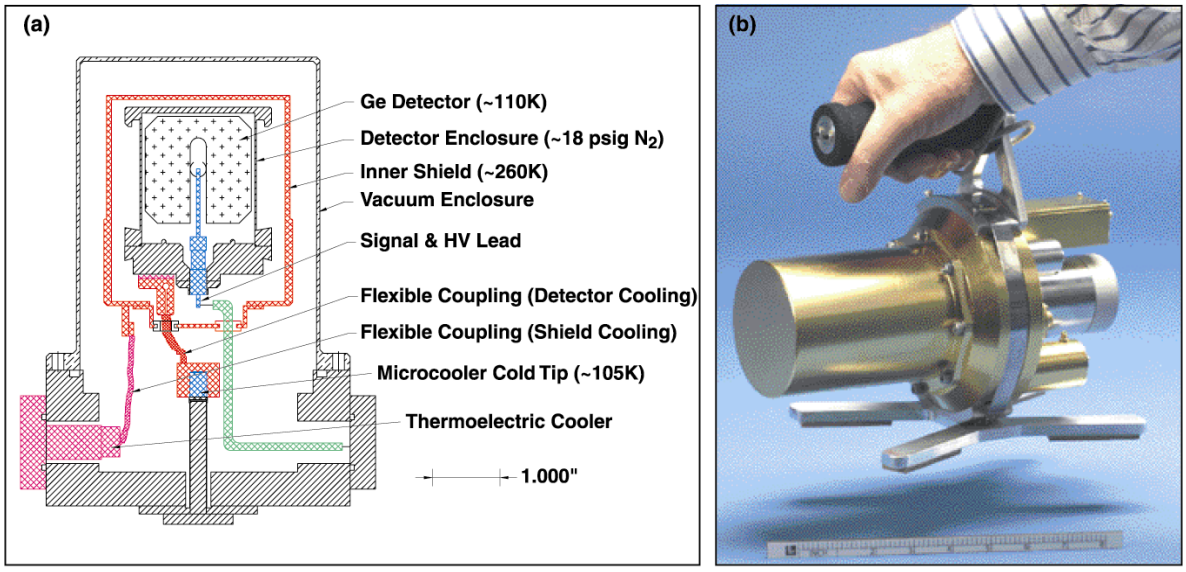

Figure 1. Concept of the encapsulated Germanium detector Cryo 3/10 (a), and actualization Cryo 3/25 (b).

References

1) The Hymatic Engineering Company Limited.

2) N. W. Madden, D. F. Malone, R. H. Pehl, C. P. Cork, P. N. Luke, D. A. Landis, M. J. Pollard, "Germanium Detector Encapsulation", LBL-29857, and Proceedings of International Symposium on Gamma-Ray Line Astrophysics, Paris-Saclay, December 10-13, 1990.

This work was funded in part by DOE/NA, and performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory and Lawrence Berkeley National Laboratory, Contract No. W-7405-Eng-48 (LLNL), and Contract No. AC03 76SF00098(LBNL).

UCRL-JC-146993-SUM